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A Study of Air Pollution in
The Flathead Valley

Flathead County, Montana

June 1963- June 1964

Montana Department of Health &
Environmental Sciences

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in

THE FLATHEAD VALLEY

FLATHEAD COUNTY, MONTANA

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Data for preparation of the fuel use inventory was obtained from the Montana Power Company, the several fuel oil and petroleum dealers, the several wood products industries, the Montana Petroleum Association, the Great Northern Railroad, other industries, government offices and individuals.

Appendix A, "A Guide For More Efficient Operation of Wigwam-Type (Teepee) Wood Waste Burners to Reduce Smoke and Flyash" has been adapted from a work developed by the Oregon State Sanitary Authority entitled "Wigwam Waste Burners, General Design, Operational and Maintenance Guide", January 1962.

Conclusions and Recommendations

The Flathead Valley has a strong potential for the development of a serious air pollution situation. The problem is not yet great, but air pollution to a significant degree does exist and to the extent that corrective measures are indicated. Air pollution will become worse unless positive measures are taken to deal with the problem while it is yet manageable. Methods and programs to achieve reductions in air pollution are as follows:

1. By reducing the amount of smoke and ash emitted by "teepee" burners. Methods for achieving some improvement are indicated in Appendix A. Since, at best, however, a "teepee" burner is relatively inefficient, it is foreseeable that a silo-type incinerator may replace the conventional method. A review of Appendix A reveals that successful implementation depends on the acceptance of smoke control as company policy supported by firm plant discipline to maintain the policy.

2. By reducing the amount of smoke and ash from the burning of slash on private, state and federal lands. The best methods for achieving a reduction are not clear, but a positive program of research and demonstration will provide a suitable answer.

3. By reducing or eliminating stubble burning in agricultural operations and in the burning of weeds and brush, in other land clearing procedures and in the disposal of refuse by communities, individuals and organizations. Research in better agricultural methods will be needed. Some solutions have already been demonstrated in other states.

4. By applying controls or air cleaning equipment to other existing industrial emitters. Suitable control procedures have been demonstrated on many of the operations currently uncontrolled or inefficiently controlled. Research and demonstration projects will be necessary to provide the best solutions to the problem.

Preventive Measures

The acceptance of good air cleaning by any proposed industry or community activity as a first cost of doing business, or of operation is necessary to prevent a serious air pollution situation from developing. Dilution of atmospheric pollution by stacks alone should not be depended upon as a satisfactory or primary means of aerial waste disposal. While some dilution will take place and can be tolerated to a degree, the meteorology of the valley indicates that generally atmospheric dilution of contaminants by the use of high stacks alone is not practical as a means of air pollution control. Standards of emission and area concentrations similar to those adopted by the various California air pollution control agencies appear clearly applicable and necessary for air pollution control in the Flathead Valley.

Introduction

The objective of the Flathead Valley Study was to determine, as a baseline, the quantity and types of certain materials, especially of a particulate nature, in the air of the Valley. With this information, future projections on air quality could be made and the effect of certain industrial and domestic practices predicted. By being able to reasonably predict the influence of a certain development, the developers or the communities could better plan--frequently at a substantial saving--for facilities that would prevent injury to the air resources of the community.

While the study identified several components of significance, established the level of air pollution in the Valley, and defined clearly the air pollution potential in the area, the specific contribution both in quantity and type for several apparent pollution sources remains unexplored. The major contributors to air pollution in the Flathead Valley are as follows:

1. The smoke, fumes and ash from the burning of sawmill wastes in "Teepee" burners along with other combustion products from furnaces and boilers associated with sawmill operations.

2. The smoke and ash created by the burning of slash at logging operations.

3. The smoke and ash created by the burning of stubble, weeds and brush in land clearing from agricultural operations, highway construction and other land-clearing projects.

4. The smoke, gases, and fumes created by other industrial operations. While a serious attempt has been made to scrub or clean the effluent from some of these operations, the efficiency of the scrubbing devices and the volume of fumes and smoke not passing through the scrubbers has not been determined.

General Characteristics and Meteorology

As indicated on maps I and II, the Flathead Valley, which is about 15 miles wide and 25 miles long and slopes from north to south at a low uniform rate, lies in a timbered mountainous area of Northwest Montana on the west slopes of the Continental Divide. Canada bounds the county on the north. The elevation at Kalispell at the southern part of the county is approximately 3,000 feet. The area is essentially agricultural with some 1,200 farms included in the study area.

The wind speeds in the Valley are usually low, and inversions both at night and during the day are frequent. These two factors create a serious potential for air pollution in the Valley.

A review of Tables 1 and 2 showing hourly wind velocities less than seven miles per hour for July and October, which are representative of all months of the year, indicate extremely low wind speeds for nearly all months of the year. Tables 3 and 4 indicate, in addition, a large number of inversions occurring during the night and extending into the day. Although there is some variation in wind speeds throughout the Flathead Valley, the average annual wind speed of close to five miles per hour as determined at the Kalispell Airport is representative of the whole valley except for certain minor variations. Wind speeds seven miles per hour or less are shown because such speeds are insufficient to provide effective lateral dilution of air pollutants.

Fuel Use Inventory and Pollution Sources

A review of Tables 5 and 6, the Fuel Use and the Emission Inventories for the Flathead Valley, suggests the major contribution to air pollution to be from the forest products industry from the burning of saw mill wastes. Slash burning and land clearing, including stubble burning, add to the total load during the fall and winter seasons. In addition, the aluminum plant is a contributor to some degree as well as that from vehicles and from trash burning done both inside and outside the cities. Most of the communities used a land-fill technique for the disposal of garbage and trash although some trash burning was noted being done at private homes both in the organized communities and in rural areas.

Table 8, a summary of measured atmospheric concentrations, shows Columbia Falls with the greatest air pollution comparable, in some respects, to Missoula with a much higher population density.

A review of the column on total suspended particulate indicates that, as would be expected, the dusty or higher wind velocity months of March through August produce a total particulate greater than during other periods of the year. The tar fraction column, however, reflects a different pattern with the higher tar fractions occurring during the colder months of the year when wind speeds are lowest and inversions greater and heating at a maximum. The lead values are not especially informative except to use as an index of the pollution potential and also the contribution from vehicles. As was expected, the concentrations of lead were almost in direct proportion to the population density and considerably less than other communities of larger population in the State.

The fluorides column indicates Columbia Falls with a higher fluorides concentration than any other city in the study area. The major contributor to fluorides in the Flathead Valley is the aluminum mill located at Columbia Falls.

The sulphate concentrations were all low and represent normal activity. With the addition of a pulp mill, the probability of an elevation in concentration would exist, as has been proven elsewhere. The sulphate measurements were made to serve as a guide line or bench mark for future sampling since it is a good measure of determining the contribution of typical sulphate pulping operations.

The laboratory evaluation of the carcinogenic properties of the benzene soluble fraction of the total suspended particulate indicated in Table 8 has not yet been completed, but will certainly show a number of these materials to be present including benzo-a-pyrene, a known strong carcinogen. The concentrations of these organic carcinogens will be added to the report when they are received from the United States Public Health Service Laboratory in Cincinnati, Ohio. A discussion of the physiological response to these and other suspected carcinogen agents is found in the 1961-62 study of air pollution in Montana published by the Montana State Board of Health.

Chemical Analyses

The chemical procedures employed were the same as those described in a previous study entitled "A Study of Air Pollution in Montana." The method for the determination of sulfate was that described by the U.S. Public Health Service, Chemical Research and Development Section, as the "Determination of Water Soluble Sulfates in Air Particulate Matter Collected on Glass Fiber Filter Webs."

Sampling Stations

Three sampling stations were utilized in this study and were located at Kalispell atop the high school and operated by the chief school custodian; at Columbia Falls atop the high school and operated by the chief school custodian; and at Creston operated by the manager of the Montana experiment farm.

All operation was voluntary and performed every third day for a year. Weekends and holiday collections were made if the sampling day happened to occur during such a period.

The samplers, General Metal Works high volume blowers fitted to hold type A Gelman 8" x 10" glass fibre filters, were located about 25 feet above ground level except at Creston where the height was about ten feet.

APPENDIX A

A GUIDE FOR MORE EFFICIENT OPERATION OF WIGWAM-TYPE (TEEPEE) WOOD WASTE BURNERS TO REDUCE SMOKE AND FLYASH

A. WOOD RESIDUE FUEL.

1. SUPPLY UNIFORM LOADING RATE OF COMBUSTIBLE WOOD WASTE.

   A. WITH STORAGE FACILITIES IF NEEDED.

   B. WITH DRYING FACILITIES IF NEEDED.

   C. BY MIXING GOOD COMBUSTIBLES AND POOR COMBUSTIBLES.

2. CONVEYORS.

   A. USE DRAG CHAINS AND/OR CYCLONES.

   B. ENCLOSE DRAG CHAIN CONVEYOR SYSTEM WHEN NEEDED.

   C. LOCATE WOOD WASTE DROP-OUT AREA FROM CONVEYOR AT OR NEAR THE CENTER OF THE BURNER UNDER-FIRE AIR SYSTEM.

3. START UP FIRES.

   A. USE GOOD COMBUSTIBLE WOOD WASTE OR AUXILIARY FUEL.

   B. START FIRE EARLY ENOUGH TO REACH COMBUSTION TEMPERATURE IN THE BURNER BEFORE MILL PRODUCTION STARTS.

B. AIR

1. OVER-FIRE

A. TANGENTIAL SCOOPS. COUNTER OR CLOCKWISE, DEPENDING UPON LOCAL CONDITIONS.

B. PROVIDE ADJUSTABLE LOUVRES, SLIDING PANELS OR SIMILAR DEVICES.

C. INLET AREAS SHOULD BE SIZED SO THAT EXCESS AIR WILL BE APPROXIMATELY 200% AT THE MAXIMUM LOADING RATE.

D. PROVIDE CENTRAL CONTROL DEVICES TO ALLOW ADJUSTMENT OF ALL OVER-FIRE AIR INLETS AS NEEDED IN LARGE BURNERS.

2. UNDER-FIRE

A. CENTRIFUGAL BLOWER ADJUSTMENT MADE BY CURTAILING AIR FLOW FROM OR TO BLOWER, OR BY USE OF VARIABLE HORSEPOWER BLOWERS.

B. NUMBER OF BLOWERS AND ADJUSTMENT OF BLOWER CAPACITY DEPENDENT UPON BURNER LOADING RATE, FUEL CONSISTENCY, CONVEYOR SYSTEM, FUEL SPECIES, ETC.

C. BURNERS EQUIPPED WITH TUNNELS SHOULD HAVE AT LEAST FOUR ENTRANCES WITH PROVISIONS FOR ADJUSTABLE DOORS TO EACH TUNNEL ENTRANCE. LOCATION OF TUNNELS DEPENDENT UPON CONDITIONS LISTED IN ITEM 2B.

D. GRATES, CONES OR SIMILAR DEVICES ARE LOCATED ABOVE UNDER-FIRE AIR DISCHARGE. SUFFICIENT POSITIVE PRESSURE HEAD IS NEEDED THROUGH DEVICE(S) TO KEEP PLUGGING FROM OCCURRING.

E. MAXIMUM DESIGN PROVISION FOR MAXIMUM UNDER-FIRE AIR AREA TO SATISFY THE MAXIMUM BURNING RATE.

B. AIR (CONTINUED)

3. ADJUST OVER-FIRE TO UNDER-FIRE AIR BALANCE FOR NO OR MINIMAL SMOKE, FLYASH AND CINDER EMISSION.

   A. DESIGN FOR MORE OVER-FIRE THAN UNDER-FIRE AIR. THE RATIO USED SHOULD BE DEPENDENT UPON THE CONDITIONS LISTED IN ITEM 2B. UNDER-FIRE AIR IS USUALLY NOT MORE THAN 10-35% OF THE TOTAL AIR SUPPLIED.

   B. ADJUSTMENT SHOULD BE MADE BY AN OPERATOR EXPERIENCED WITH COMBUSTION AND WIGWAM BURNER OPERATIONS.

4. CONTROL OF EXCESSIVE AIR.

   A. PROVIDE BETWEEN 200% AND 400% OF THE THEORETICAL AIR REQUIREMENT FOR COMBUSTION. (FOR THIS RANGE THE BURNER EXIT TEMPERATURES WILL BE APPROXIMATELY 900° F. TO 600° F.).

   B. KEEP ALL DOORS CLOSED DURING OPERATION OF THE BURNER.

   C. LEAKS IN THE SHELL PANELS, BURNER BASE, ETC., SHOULD BE SEALED. FRAME CONSTRUCTION SHOULD ALLOW FOR REPLACEMENT OF INDIVIDUAL BURNER PANELS.

5. WEEKLY CLEANOUT OF UNDER-FIRE AIR SYSTEM. CLEANOUT OF ASH AND RESIDUE AS NEEDED FOR ADEQUATE AIR FLOW INSIDE THE BURNER.

C. GENERAL OPERATIONAL AND MAINTENANCE ITEMS.

1. OVER-ALL RESPONSIBILITY FOR FUNCTIONAL ASPECTS OF BURNER SHOULD BE DELEGATED TO ONE PERSON FOR EACH BURNER OPERATING SHIFT. THE INDIVIDUAL APPOINTED SHOULD BE EXPERIENCED WITH COMBUSTION AND WIGWAM BURNER OPERATION.

2. PROVIDE FOR PERIODIC INSPECTIONS OF PHYSICAL CONDITION OF BURNER INCLUDING ALL APPURTENANCES. INSPECTIONS SHOULD BE MADE BY AN INDIVIDUAL EXPERIENCED WITH COMBUSTION AND WIGWAM BURNER OPERATION.

3. THE RESPONSIBLE BURNER OPERATOR MUST BE ADVISED OF ALL MILL OPERATIONS SO THAT CHANGES CAN BE ANTICIPATED AND BURNER OPERATION CORRELATED WITH MILL ACTIVITY.

4. THE BURNER OPERATOR MUST HAVE SUFFICIENT AUTHORITY TO DIRECT WASTE DISPOSAL PRACTICES, TO CHOOSE STORAGE OF CLEAN-UP MATERIALS AND TO PREVENT OPEN BURNING.

TABLE I

Hourly Wind Velocity Less Than 7 Miles Per Hour

Flathead County Airport
July 1963

c = calm

Date	A. M.												P. M.											
	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid't
1	4	4		4							4		4	3	6								5	
2										5	4	4	4	6	4	2	3	4	c	c	3	5	c	3
3	3	4	4	4	3	4	5	5	6	3	2	3	3	3										
4			6	6	3	3	6	4	4	5	3	3	4	3	2	3	2	6	3	2		6	5	6
5	3	3	3	2	3	4	3	6	3	2	2	4	3	4	3	6		6	3	3			2	3
6	4	3	c	3	5	3	5	4	4	3	3	3	2	2	2	3	3	6	c	4	6	4		7
7						5	5					4	3	3	2	2	4		2					4
8	3	2	5		6	c	5	4	5	3	4	5	6	6	6			4	5	3	3		2	3
9		3	2	2	2	2	2	4	2	3	4	2	4			3	5	3	4	2	3	c	3	4
10	4	2	5	3	3	2	3	2	3	3	c	3	3	4			5			6	4		5	4
11	4	4	3	3	3	2	4	6		5			6								6	5	5	c
12	5	2	4	c	5	2	c	3	3							6		6	6	3	3	3	2	2
13	2	3	c	3	c	2	3	2	c	4		5							4	2	2	c	3	2
14	4	3	3	2	3	3	4	3	4	2	4					4		3	5	4		5	4	5
15	3	5	4	5	6	3	6													2		2	4	2
16	2	2	2	3	c	3	2	2	5	4	6	2		6	2	4		5	5	4	2	3	4	3
17	2	2	2	2	3	c	6	3	4		2	4	4	4	5				6		5	3	3	2
18	2	2	2	c	2	2	2	3						5					2	3	5	2	2	2
19	2	3	2	2	2	6	4	2	4	2	6					6		6		6	4	2	3	4
20	c	3	2	4	2	4	4	5	6	4	3	6	6	6			5	5	4	5	4	2	2	5
21	3	3	c	3	4	3	c	5	c	2	2	5						5		4	3	2	4	3
22	4	2	2	3	4	2	4	6	2	6											6	4	2	3
23	3	3	3	4	2	2	c	2	3	4			5		6		2		2	2	2	4	4	3
24	4	5		6				5			5	4		5	4	4		3			4		4	3
25	2	2	2	4	6	5	6					2		4	4	2	3	3	3	2	3	c	2	2
26	3	3	3	2	5	3	3	4		4	3	5		2	5	3	4	4	4	5	2	4	4	c
27	2	c	2	3	2	3	3	5	4	4	6	2		4	5	4		6	5	3	2	c	c	2
28	3	5	c	3	2	2	c	2	3	4	5	3		7						5		4	c	4
29	2	c	c	c	2	4	2	2	c	3	3	4		5		4	5	5		2	c	3	2	2
30	c	c	2	2	c	3	c	2	3			5		5							4	3	3	2
31	2	2	c	3	c	3	2	4	5	4	4	4	c	c	c	c	5	5	4	6	5			

TABLE 2

Hourly Wind Velocity Less Than 7 Miles Per Hour
Flathead County Airport
September 1963

C = calm

DATE	A. M.												P. M.											
	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid't
1	4	5	2	6	3	5	3	4	3	2	2	6	6						5	6	3	2	3	2
2	2	2	3	3	3	3	C	2	2	2	3	4	4		6	5	5		6	6	3	C	3	2
3	2	2	2	3	3	C	C	C	2	C	4	3	4	6	5	6		5	4	3	2	4	2	2
4	3	2	2	3	3	3	6	3	4	3	4	5							4	4	5	2	2	2
5	3	2	C	C	2	C	C	2	2	2	3			5	5				4	6	4	3	3	4
6	4	2	2	3	3	2	3	4			5	6				5				4	4	C	C	C
7	4	3	2	2	2	3	2	4	2	2	C			4				3	2	2	4	3	C	3
8	2	C	2	4	4	4	4	3	4	4	2								4	4	3	5	2	2
9	3	2	4	2	C	C	3	4	3	5	2	5								6			6	6
10	3	5	4	5	3	5	6	3	6		4	2	3	3	4	5	4	4	5	4	4	5	6	
11						3	4			6	3	2	3	2		5	3				6		4	4
12	3	2	4	5		4	6				3	2	3	C	C	3	2	3	3	3	2	3	3	C
13	2	3	2	3	2	2	2	3	C	5						4	5		4	5	6			
14	6	2		3		6	6												6	4	2	3	5	5
15	2	2	C	3	2	2	3	3										3		4	4	4	5	4
16	5	6		3	4	5	4	3	3	2	4	4	5			6		5	2	2	3	C	2	3
17	3	2	2	3	2	3	3	C	2	C	5	4	2	4	4	6		4	2	4	4	C	2	C
18	2	2	3	3	2	C	3	C	2	3	3	4	3	4	5	6	3	4	C	C	3	4	3	2
19	2	C	6	3	4	3	2	2	4	C	4	3	3	4	4	4	2	3	C	2	2	3	2	4
20	6	5	6					6	3				3	2	C	3	3	C	C	C	3	C	C	2
21	4	2	2	2	5	5	6	5	3	6	4	3	4	4	3	6			C	4	2	3	3	C
22	C	4	2	3	2	3	3	3	5	2	3	3	3					4	2	3	4			
23	C	2	4	3	C	2	C	2	C	5								5	6	6			3	4
24	3	3	3	2	2	3	3	3	C	2	2	5						5	2	3	3	C	2	2
25	2	C		5	3	3	2	3	2	3	2	3	2	4	6				3	2	2	2	2	C
26	2	2	3	2	4	2	3	3	3	3	2	2	3	4	3	3	3	2	2	4	2	3	3	2
27	2	C	3	C	2	2	2	C	4	2	2	3	2	4	3	4	C	C	3	5	3		5	
28		6		4		4	5	5				4	2	2	3	2	C	3	4	6	2	3	2	4
29	3	2	4	C	3	4	3			4	6	5	5	5		6	4	C	3	3	5	C	3	2

TABLE 3

Inversions Occuring During Night of Any Length
Flathead Valley - 1963

	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
1	X	X		X	X	X^{s}
2	X	X	X	X		X^{s}
3	X	X	X	X	X	X^{s}
4	X	X	X	X	X	X^{s}
5	X	X	X	X		X^{s}
6	X	X	X	X		
7	X	X	X	X		
8	X	X	X	X		X
9	X	X	^{s}X	^{s}X		
10		^{s}X	^{s}X	X	X^{wk}	
11		X		X		X^{s}
12	X	X	X	X^{s}	X	X
13	^{s}X	X		X^{s}	X	X
14	X	X	X	X	X	X
15		X	X	X		X
16	^{s}X	X	^{s}X	X^{s}		
17	^{s}X	X	X	X^{s}		
18	X	X	^{s}X	X^{s}		X
19	^{s}X	X	^{s}X	X^{s}		X
20	X	X	X	X^{s}		X
21	X	X	X		X	X^{wk}
22	X	X	^{s}X			
23	^{s}X	x	x		x	X^{wk}
24		x	X			X
25		X	X			
26	X		^{s}X	X^{lgt}		X
27	X	X	^{s}X	X^{lgt}		X
28	X	X	X	X^{lgt}		X
29	X		X	X^{wk}	X^{s}	X
30	^{s}X		X	X^{wk}	X^{s}	X
31	^{s}X	X		X		X

X = inversion
X^{s} = strong inversion

TABLE 4

INVERSIONS OCCURING DURING HOURS OF 6 A.M. TO 6 P.M.
Flathead Valley - 1963

	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
1	X			X	X	X^{s}
2		X	X	X		X^{s}
3		X	X	X	X	X^{s}
4	X	X	X	X	X	X^{s}
5	X	X	X	X		X^{s}
6	X	X	X	X		
7		X	X	X^{s}		X^{wk}
8	X	X	X	X		X
9	X	X	^{s}X	X^{s}		
10		X	^{s}X	X		
11		X		X		X^{s}
12	X	X	X	X^{s}	X	X
13	X	X		X^{s}	X	X
14	X	X	X	X	X	X
15		X	X	X		X
16	X	X	X	X^{s}		
17	X	X	X	X^{s}		
18	X	X	^{s}X	X^{s}		X
19	X	X	^{s}X	X^{s}		X
20	X	X	X	X^{s}		X
21	X	X	X		X	X^{wk}
22	X	X	^{s}X			X
23	X	X	X		X	X^{wk}
24			X			X
25		X	X			
26	X to 1000		^{s}X	$X^{v.lgt}$		X
27		x	^{s}X	X^{lgt}		X
28	X	X	^{s}X	X^{lgt}		X
29	X		X	X^{wk}	X^{s}	X
30	x		^{s}X	X^{wk}	X^{s}	X
31	X	X		X		X

x = inversion
X^{s} = strong inversion

TABLE 5

FUEL USE INVENTORY
FLATHEAD VALLEY

TYPE OF CONSUMER	FUEL	ANNUAL CONSUMPTION	REFERENCE	COMMENTS
Industrial, Commercial & Public Utilities	Coke	51,000 tons		
	Coal tar pitch	11,300 tons		
	Coal	800 tons		
	Natural Gas	1,065,530,000 cu. feet	b.	
	Fuel Oil	2,000,000 gals.	a. c.	
	Wood Waste	320,000 tons		does not include 1000 acres of slash burn or 1400 acres of field stubble burn
	Trash	513 tons	d. g.	
Domestic	Coal	Negligible	a.	
	Natural Gas	327,809,000 cu. feet	b.	
	Fuel Oil	1,750,000 gals.	a. c.	
	Trash, Wood & Mixed Refuse	1,216 tons	e. g.	Landfill methods used mostly - 20% open burning estimate.
Vehicular	Gasoline	11,118,803 gals.	f.	
	Diesel Fuel:			
	Trucks	1,770,000 gals.	a. c.	
	Railroads	832,000 gals.	c.	

a. Fuel dealer contacts
b. Public untility Co.
c. Industry Contacts
d. Based on estimats of 270#/cap/yr
e. Based on estimate of 640#/cap/yr
f. Montana Petroleum Association
g. City - County Government

TABLE 6

Emission From Combustion Operations
Flathead Valley Study Area
(Pounds per day averaged over the Year)

Pollutant	Source and Amount of Emission														
		Industrial and Commercial							Domestic				Vehicular		
	Total Emissions	Total	Fuel Oil	Gas	Coal	Coal Tar Pitch (b)	Wood Wastes	Trash	Total	Fuel Oil	Gas	Trash	Total	Gas-oline	Diesel Fuel
Sulfur Dioxide	4,118	2,103	685	344	84	695	292	3	716	605	105	6	1,299	955	344
Carbon Monoxide	68,537	37,160	190	220	46	2	36,700	2	157	25	67	65	31,220	25,900	5,320
Hydrocarbons														97,280	
Oxides of Nitrogen as NO_2	7,162	3,480	493	732	46	5	2,200	4	252	65	179	8	3,430	1,780	1,650
Sulfur Trioxide	279	199	76	36	10	77			80	68	12				
Organic Acids as CH_3COOH	1,839	1,484	570	177		6	730	1	131	75	54	2	224	127	97
Aldehydes as CH_3CHO	3,821	3,430	68	59		1	3,300	2	40	9	27	4	351	232	119
Lead Halide	64												64	64	
Ammonia	67												67	67	
Carbon, Tars, & Oils (five)	9,194	4,112	10		46	296	3,760		2	2			5,080	4,440	640
Carbon & Resins (coarse)	183,033	183,012					183,000	12	21			21			
Oil Mist	3,820												3,820	3,820	
Fluorides (a)	11	11					11								
Total	281,945	234,991	2,092	1,568	232	1,082	229,993	24	1,399	849	444	106	45,555	37,385	8,170

(a) Industrial production of fluoride is 11,800#/day after cleaning or not captured in cleaning device

(b) Calculated on same basis as fuel oil

TABLE 7

SUMMARY OF MEASURED ATMOSPHERIC CONCENTRATIONS
of
SULFUR DIOXIDE NEAR KALISPELL AND COLUMBIA FALLS IN PARTS PER MILLION

(Lead peroxide candle method)

COMMUNITY	YEAR	SEASON	NUMBER OF SAMPLES	CONCENTRATION - PPM		
				MIN.	MAX.	AVERAGE
Kalispell	1963-64	Year	7	0.004	0.03	0.009
Columbia Falls	1963-64	Year	8	0.005	0.005	0.005

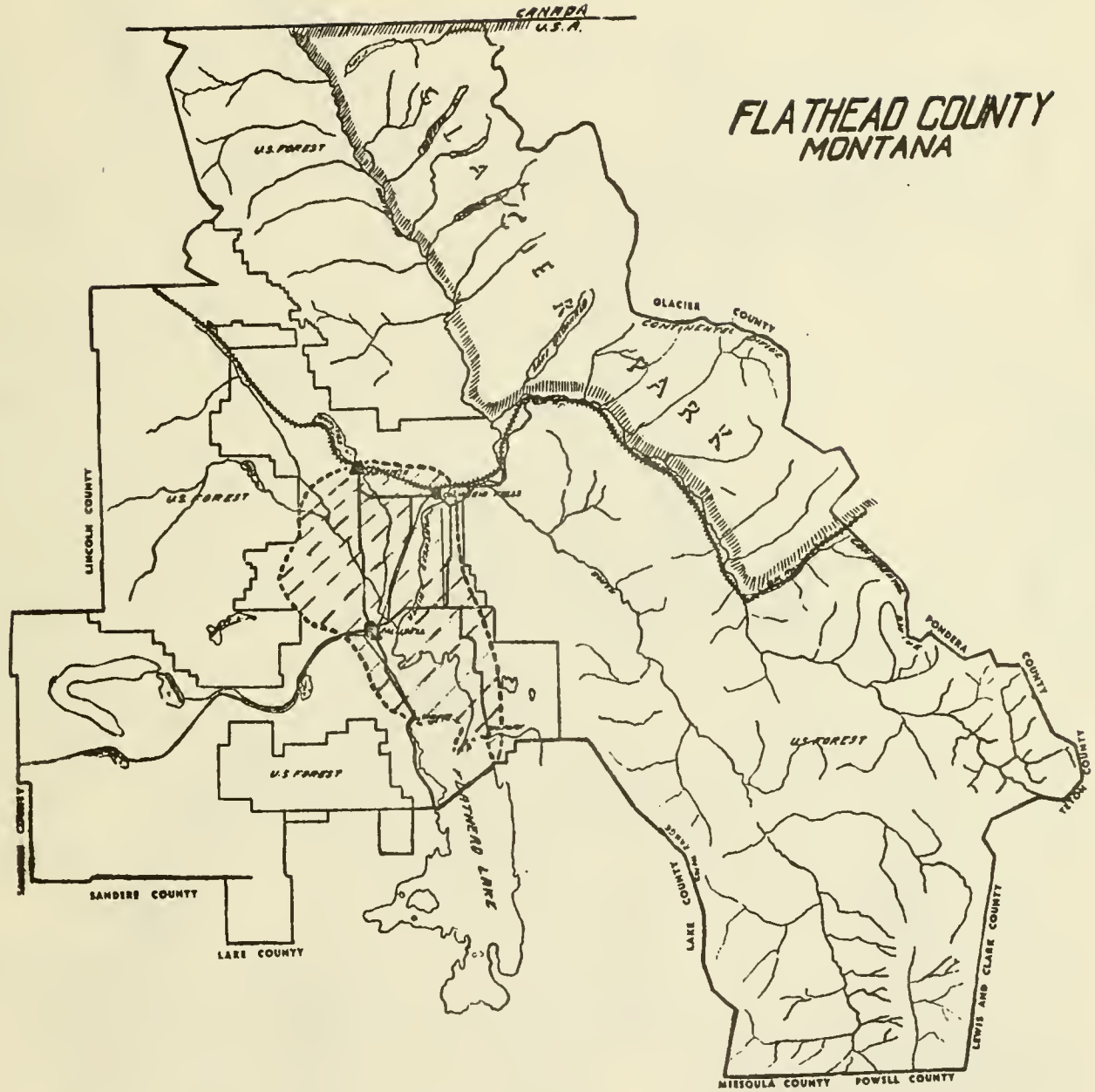
This method is useful in suggesting average low level concentrations of sulfur dioxide over a long period of time but does not record high concentrations which may exist for short periods. The usefulness also diminishes at higher levels of exposure which may exist for long periods of time.

TABLE 8

Summary of Measured Atmospheric Concentrations of Total Suspended Particulate, Benzene Soluble Fractions, Lead, Fluorides and Water Soluble Sulfates in Three Communities of the Flathead Valley

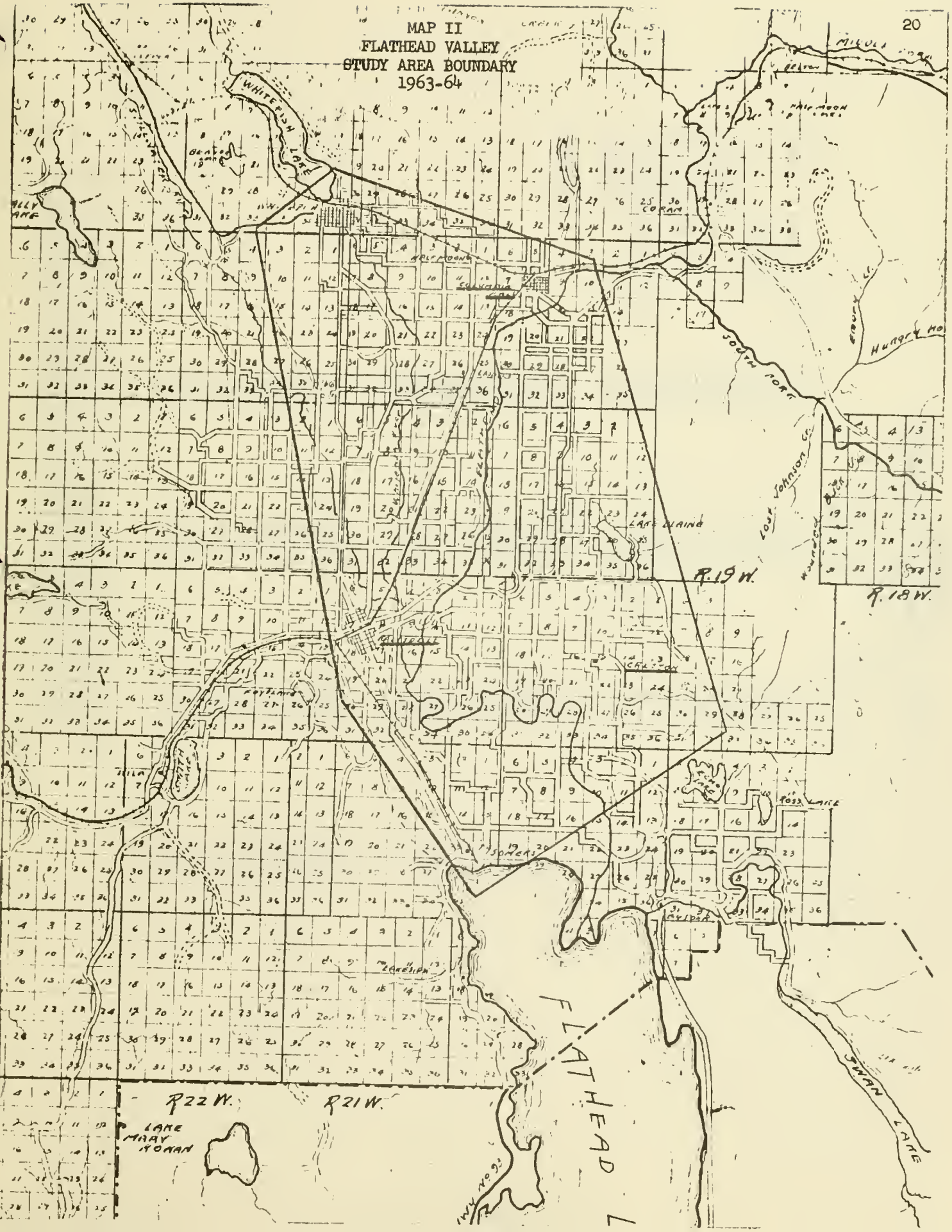
Community	Year	Season	Number of Samples	Concentrations of Specific Pollutants in Micrograms per Cubic Meter of Air														
				Total Susp. Part.			Benz. Sol. Frac.			Lead			Fluorides			Sulfate		
				Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Creston	1963-64	Year	82	5	179	41	1.3	21.7	7.2	0.0	0.26	0.04	0.0	0.21	0.05	0.17	6.1	0.74
		Sept-Feb	52	5	100	37	1.3	21.7	8.0	0.0	0.26	0.06	0.0	0.21	0.06	0.18	5.90	0.45
		Mar-Aug	30	6	179	56	2.1	12.5	6.8	0.0	0.06	0.01	0.0	0.21	0.03	0.17	6.1	1.22
Kalispell	1963-64	Year	87	10	169	65	2.3	67.0	11.8	0.0	0.49	0.10	0.0	0.23	0.05	0.0	6.6	0.84
		Sept-Feb	53	10	155	60	6.1	67.0	14.1	0.0	0.49	0.29	0.0	0.19	0.05	0.0	6.6	0.56
		Mar-Aug	34	18	169	76	2.3	17.6	7.2	0.0	0.13	0.05	0.0	0.23	0.06	0.0	6.3	1.07
Columbia Falls	1963-64	Year	81	7	582	104	1.5	28.4	10.8	0.0	0.43	0.05	0.0	0.85	0.25	0.0	6.2	0.75
		Sept-Feb	47	7	582	95	1.9	28.4	12.3	0.0	0.43	0.07	0.0	0.85	0.32	0.0	6.2	0.36
		Mar-Aug	34	11	411	103	1.5	18.1	8.2	0.0	0.16	0.03	0.0	0.52	0.20	0.2	4.0	1.17

MAP I



Study area ////////

MAP II
FLATHEAD VALLEY
STUDY AREA BOUNDARY
1963-64



-ADDENDUM-

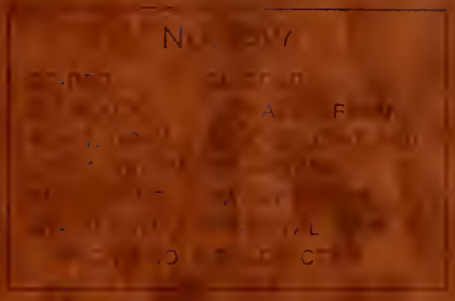
POLYNUCLEAR HYDROCARBON ANALYSIS
of
AIR IN FLATHEAD VALLEY

		UG/G BS*	UG/G PART**	UG/1000CU M***
CRESTON Fluoranthene -	FLT	298.6	21.5	2.1
Pyrene -	PYR	286.9	20.7	2.0
Benz(a)anthracene -	BAA	75.9	5.5	0.5
Chrysene -	CHY	356.5	25.7	2.5
Benzo(e)pyrene -	BEP	219.1	15.8	1.5
Benzo(a)pyrene -	BAP	167.3	12.1	1.2
Perylene -	PER	17.3	1.3	0.1
Benzo(g,h,i)perylene -	GEE	115.6	8.3	0.8
Anthanthrene -	ANT	7.6	0.5	0.1
Coronene -	COR	37.2	2.7	0.3
KALISPELL	FLT	356.0	41.6	4.5
	PYR	366.9	42.8	4.7
	BAA	96.8	11.3	1.2
	CHY	394.1	46.0	5.0
	BEP	270.1	31.5	3.4
	BAP	234.7	27.4	3.0
	PER	25.6	3.0	0.3
	GEE	187.5	21.9	2.4
	ANT	8.4	1.0	0.1
	COR	82.3	9.6	1.0
COLUMBIA FALLS	FLT	258.3	12.6	2.7
	PYR	250.0	12.2	2.6
	BAA	251.3	12.3	2.7
	CHY	844.8	41.2	8.9
	BEP	782.9	38.2	8.3
	BAP	783.0	38.2	8.3
	PER	70.3	3.4	0.7
	GEE	429.8	21.0	4.5
	ANT	24.5	1.2	0.3
	COR	91.7	4.5	1.0

* Micrograms of hydrocarbon per gram of Benzene Soluble Tar.
** Micrograms of hydrocarbon per gram of Total Particulate.
*** Micrograms of hydrocarbon per 1000 cubic meters of air.

The table in the addendum showing the polynuclear hydrocarbon analysis is of interest because of the strong relationship of such materials as benzo(a)pyrene to the rising increase in lung cancer. It is known that benzo(a)pyrene is a strong carcinogenic agent and has been shown by Sawicki and others in a publication entitled "Benzo(a)pyrene Content of the Air of American Communities" to be universally present in community air and in cigarette smoke. Benzo(a)-pyrene is believed to come principally from the incomplete combustion of fuels, waste materials and other combustible substances but especially from the distillation or combustion of fuels.

In comparison with other communities in the State where this material and other polynuclear hydrocarbons have been evaluated, the values at Creston and Kalispell do not appear to be especially high but not necessarily insignificant; however, at Columbia Falls a significant increase is noted. The concentration at Columbia Falls, as an example, is very nearly the same as that determined in previous studies to exist in Libby and Missoula. In terms of the potential for benzo(a)pyrene in the tar fraction, the quantity found at Columbia Falls is considerably in excess of that determined in studies of Missoula and Libby by approximately three times. The potential in the tar fraction is considerably higher than the potential in Los Angeles or San Francisco but a good deal less than that found in Birmingham or Detroit.

It is notable that even though the quantity of benzo(a)pyrene per gram of benzene soluble or tar material is much higher in the Columbia Falls area, the total concentration of tar found in the Columbia Falls samples was less than that found in either Missoula or Libby by approximately 50 per cent.

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